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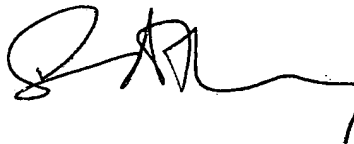
PCT International Application No. : PCT/DE2004/001775

VERIFICATION OF A TRANSLATION

I, Susan ANTHONY BA, ACIS,
Director of RWS Group Ltd, of Europa House, Marsham Way, Gerrards Cross,
Buckinghamshire, England declare:

That the translator responsible for the attached translation is knowledgeable in the German language in which the below identified international application was filed, and that, to the best of RWS Group Ltd knowledge and belief, the English translation of the international application No. PCT/DE2004/001775 is a true and complete translation of the above identified international application as filed.

I hereby declare that all the statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the patent application issued thereon.



Date: February 2, 2006

Signature :

For and on behalf of RWS Group Ltd

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- 1 -

Use of a layer consisting of hydrophobic, linear or two-dimensional polycyclic aromatics as a barrier layer or an encapsulation and electric components constructed with a layer of this type and comprising organic polymers

Electrical components constructed from organic material are increasingly being investigated with a view to their possible uses, since they offer advantages over the typically used semiconductor components. For example, it is known that certain organic materials can be excited to emit light by an electrical charge. Numerous structures of OLEDs (organic light-emitting diodes) have therefore already become known. It has been found that the optically active layer is appropriately composed of a plurality of layers, in which case at least one layer is configured specifically for hole formation (hole injection layer, HIL) and for hole conduction (hole transport layer, HTL), and another layer especially for electron release (electron injection layer, EIL), for electron transport (electron transport layer, ETL) and for light emission (emission layer, EML).

The known structure of such OLEDs envisages a glass substrate on which a transparent anode composed of a transparent conducting oxide (TCO) has been formed, for example from indium tin oxide (ITO). To this arrangement are applied in succession, for example, an HIL, HTL, EML, ETL and EIL, and finally a metallic cathode. In this structure, the light is radiated "downward", i.e. through the substrate.

With regard to the material selection, OLEDs of the known type are constructed either only from layers of different small molecules (SM-OLED, small molecule OLED) or from different polymers (PM-OLED). The small molecules are applied in succession to the substrate as

thin layers by vacuum sublimation. In contrast, polymers are processed from a solution (water or organic solvents). In particular, polymer layers offer advantages as the HIL and HTL, since they exhibit good hole transport properties. Known molecules which are suitable as HILs are, for example, anthracene, tetracene and pentacene (cf. EP 0 278 758 B1).

Since the application of the layers composed of small organic molecules is less problematic, but the layers composed of polymers offer advantages for hole conduction, attempts have been made to undertake a combination of these layers. This is possible in the conventional structure of an OLED when the HIL and HTL polymer layers relevant for hole conduction are applied to the anode (composed of ITO) in the wet state and subsequently dried and vacuum-degassed. The subsequent application of the small molecules by vacuum sublimation is then possible without any problems.

In order to enable direct light radiation, attempts are increasingly being made to realize an inverse structure of an OLED in which the metallic cathode is thus applied to any substrate and then the electron-conducting layers are formed first before the hole-conducting layers are applied and concluded with a transparent anode. For this structure, a hybrid technique is not possible, since, in the case of the wet formation of the hole-conducting HTL and HIL layers, the small molecules of the electron-conducting layers would be attacked by the solvent or dispersant from which the polymers for HTL and/or HIL are applied (for example water), and become unusable in terms of their electrical quality; the metallic cathode is also moisture-sensitive and can be destroyed by contact with water.

It is also known that the layers of the OLEDs are highly moisture-prone, so that the OLEDs, after the

application of the second electrode, are encapsulated in such a way that only connections of the electrodes are accessible.

- 5 The proneness of organic materials to moisture also constitutes a problem in other electrical components.

The distinction undertaken above between "small molecules" and polymers has been accepted in the technical field and is customary. "Small molecules" are therefore those organic molecules which do not form chains or networks by polymerization.

15 It is therefore an object of the present invention to eliminate or at least to reduce the restrictions which exist as a result of moisture sensitivity and as a result of diffusion phenomena for the construction of electrical components from organic substances.

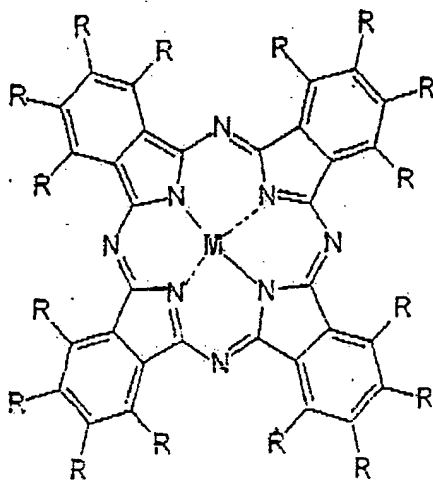
20 Surprisingly, this object is achieved by the use of a layer composed of hydrophobic, linearly or two-dimensionally polycyclic aromatic having from three to twelve ring structures including metal-containing or metal-free phthalocyanines, which have, as radical groups, -H and/or -F, alkyl groups, aryl groups and/or fluorinated hydrocarbons, as a barrier layer in or as an encapsulation of electrical components constructed with organic layers.

30 The present invention is based on the fact that the layers mentioned, especially and preferably composed of pentacene, can be not only a functional layer in the formation of organic electrical components, but unexpectedly has barrier layer properties which enable the corresponding layer to be used as a barrier layer against moisture for the protection of the layers below it and of the metallic cathode.

The layer used in accordance with the invention has preferably been formed from a material from the group of anthracene, phenanthrene, tetracene, chrysene, pentacene, hexacene, perylene, triphenylene, coronene, m-naphthodianthracene, m-anthracenoditetracene, m-tetracenodipentacene, pyrene, benzopyrene, ovalene, violanthrene and derivatives of the aforementioned substances, with radical groups -H and/or -F, alkyl groups, aryl groups and/or fluorinated hydrocarbons.

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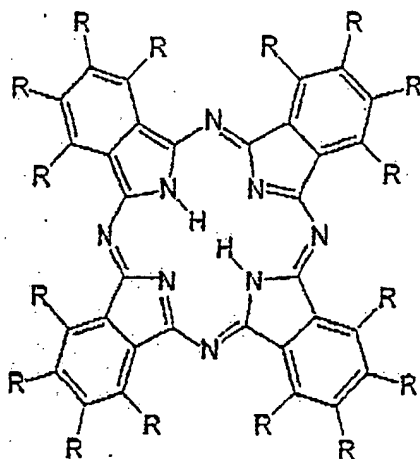
Alternatively, the layer may be formed from a metal-containing phthalocyanine of the formula



15 where M = Cu, Zn, Fe, Mn, Co, Ni, V = O, Ti = O, and each R may be an -H and/or -F and/or an alkyl group and/or an aryl group and/or a fluorinated hydrocarbon.

Alternatively, the layer may be formed from a metal-free phthalocyanine of the formula

20



where M = Cu, Zn, Fe, Mn, Co, Ni, V = O, Ti = O, and each R may be an -H and/or -F and/or an alkyl group and/or an aryl group and/or a fluorinated hydrocarbon.

5

In all cases, it is preferred when the number of ring structures of the aromatic is between 5 and 10, preferably between 4 and 10, more preferably between 5 and 8.

10

Owing to the illustrated use of the layer described in detail as a barrier layer or encapsulation, it is possible to construct organic electrical components in which the layer both fulfills an electrical function and has been formed as a barrier layer or as an in situ encapsulation.

15

Accordingly, according to the invention, an organic light-emitting diode having a substrate, a first electrode applied to the substrate, at least one electron-injecting and -transporting zone, at least one hole-injecting and -transporting zone and a second electrode, is characterized in that the hole-injecting and -transporting zone a layer composed of polycyclic aromatics having linear or two-dimensional chains and from 3 to 12 ring structures including metal-containing or metal-free phthalocyanines, which has, as radical groups, -H and/or -F, alkyl groups, aryl groups and/or

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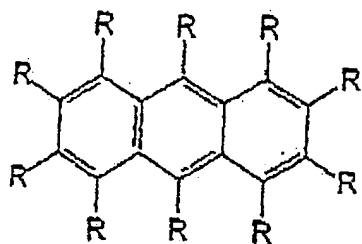
fluorinated hydrocarbons, this layer being in the form of an encapsulation layer.

5 According to the invention, the layer mentioned not only forms a functional layer but also performs an in situ encapsulation. For this purpose, the layer structure is such that the layer covers all previously constructed, moisture-sensitive layers.

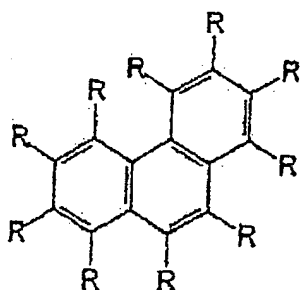
10 The invention also makes possible an organic light-emitting diode having a substrate, a cathode applied to the substrate, at least one electron-injecting and -transporting zone, at least one hole-injecting and -transporting zone and a light-transparent anode,
15 wherein the electron-injecting and -transporting zone is constructed with small molecules, and it is adjoined toward the anode by a layer composed of polycyclic aromatics having linear or two-dimensional chains and from 3 to 12 ring structures including metal-containing
20 or metal-free phthalocyanines, which, as radical groups, -H and/or -F, alkyl groups, aryl groups and/or fluorinated hydrocarbons.

The present invention therefore also enables an organic
25 light-emitting diode (OLED) which has been constructed in a hybrid structure and in which the radiation is "upward", i.e. away from the substrate side. Accordingly, the invention enables an optimized structure of an upward-radiating OLED, since the layer
30 mentioned functions as an efficient barrier layer which prevents the diffusion of water into the layers below it. Accordingly, it is possible to apply with preference to the layer mentioned, toward the anode, an aqueous polymer film, for example composed of PDOT:PSS,
35 in aqueous form as an additional hole-injecting layer, in order to reduce the required operating voltage of the OLED.

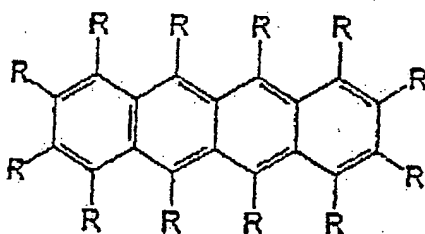
Examples of substances from which the layer serving as a barrier layer or encapsulation in accordance with the invention can be formed are:



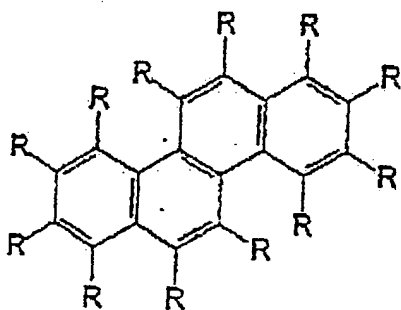
anthracene



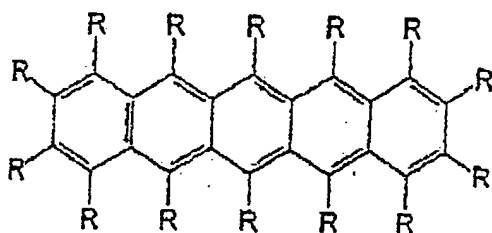
phenanthrene



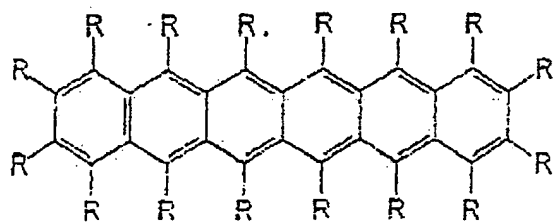
tetracene



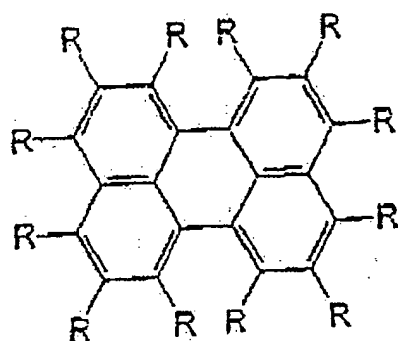
chrysene



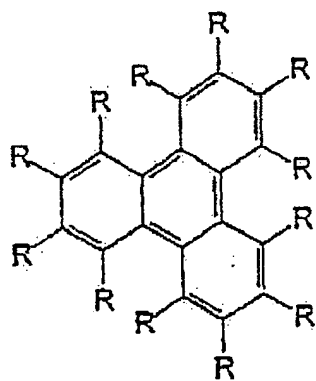
pentacene



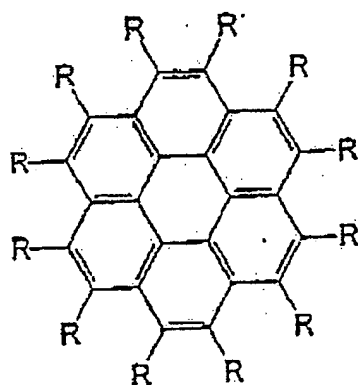
hexacene



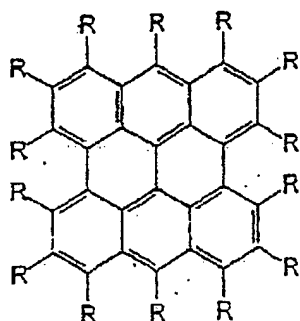
perylene



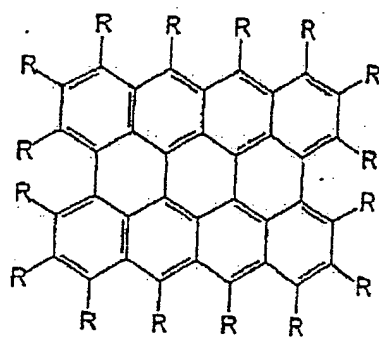
triphenylene



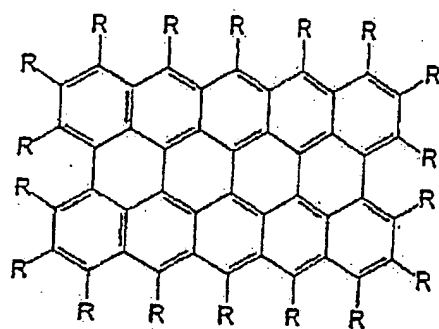
coronene



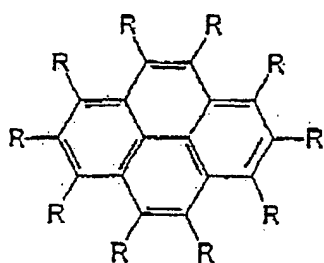
m-naphthodianthracene



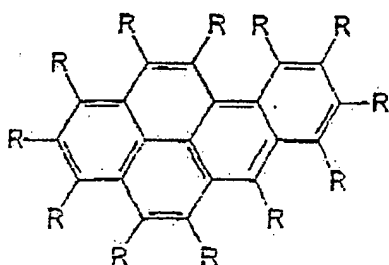
m-anthracenoditetracene



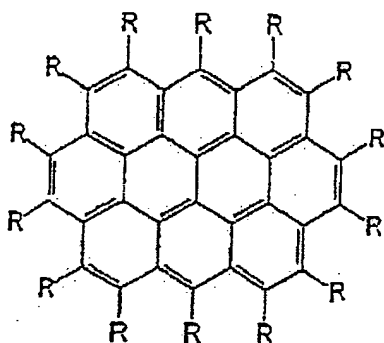
m-tetracenodipentacene



pyrene

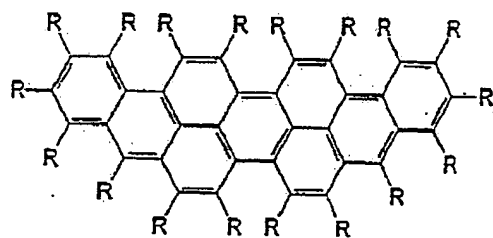


benzopyrene



ovalene

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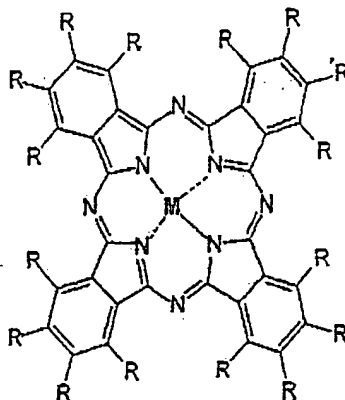


violanthrene

R = H and/or F and/or alkyl, aryl,
And/or fluorinated hydrocarbons

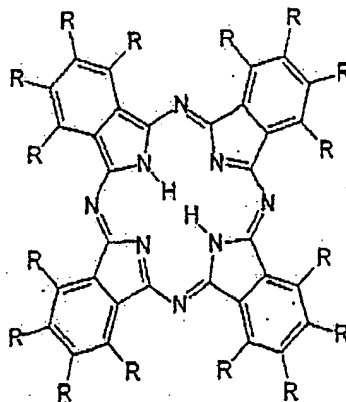
phthalocyanine

metal-containing



M = Cu, Zn, Fe, Mn, Co, Ni, V=O, Ti=O

metal-free



R = H and/or F and/or alkyl, aryl,
And/or fluorinated hydrocarbons

For the sake of clarity, it should be pointed out that all of the listed molecules of this layer, even when up to 12 ring structures are present in them, are "small molecules" in the sense of this invention, since no polymerization is present.

The invention will be illustrated in detail below with reference to working examples shown in the drawing. The drawing shows:

- 5 Figure 1 a schematic structure of an "upward"-emitting OLED with an HIL layer as an encapsulation layer, all layers being in the form of SM layers.
- 10 Figure 2 a schematic structure of an OLED with a hybrid structure composed of SM layers and a polymer layer.

The OLEDs shown in Figures 1 and 2 emit upward. They
15 consist of a substrate 1 to which a metal layer has been applied as a cathode 2. A suitable metal layer is magnesium or an alloy composed of LiF/Al.

The cathode 2 is adjoined by an electron-injecting
20 layer EIL which provides free electrons in a known manner. These recombine with holes from the remaining layers illustrated in detail below in an emission layer EML, in which the recombination gives rise to electroluminescence, i.e. light is emitted.

25 Above the emission layer EML are optionally disposed a plurality of hole-conducting layers HTLs. These are covered by a hole-injecting layer HIL 1 which may be formed from pentacene in the working example shown.
30 This layer is used as an encapsulation layer in that it is formed in the real construction such that it covers the remaining layers below it. HIL 1 is adjoined by a transparent anode 3 which preferably consists of indium tin oxide. The EIL, EML, HTL and HIL 1 layers are
35 formed as thin layers in a known manner and emit light when a positive voltage of sufficient size relative to the cathode 2 is applied to the anode 3. The emission directed upward is illustrated by an arrow in Figure 1.

As a result of the use of the HIL 1 layer as an encapsulation layer, an otherwise necessary subsequent (ex situ) encapsulation of the OLED becomes superfluous. The inventive OLED according to Figure 1
5 is therefore encapsulated in situ, so that a subsequent encapsulation can be carried out in a substantially simpler manner as a result of the lowered requirements in relation to their permeability toward water vapor.

10 In the OLED shown in Figure 2, a structure similar in principle is envisaged, the EIL, EML, HTL and HIL 1 layers all consisting of small molecules (as SM layers). Between the HIL 1 layer used as a barrier layer in accordance with the invention and the anode 3,
15 another HIL 2 layer has been applied, which is formed as a polymer layer, for example PDOT. This HIL 2 polymer layer is applied in the wet state but, owing to the barrier layer action of HIL 1, does not damage the moisture-sensitive HTL, EML and EIL layers below it.

20 The HIL 2 layer enables the working voltage between anode 3 and cathode 2 to be lowered and increases the efficiency of emission, which is also upward in the working example according to Figure 2.

25 Since the HIL 2 polymer layer is not moisture-sensitive, it is also possible in this working example for the HIL 1 layer to be configured as an encapsulation layer, i.e. to cover the HTL, EML and EIL
30 layers below it.

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